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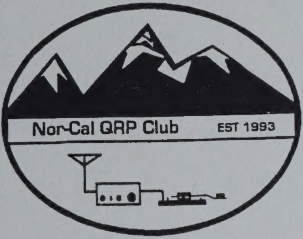

Summer
2002

Journal of the Northern California QRP Club

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From the Editor

by Doug Hendricks, KI6DS

I hope that you enjoy this issue, as it has several great articles with some meat to them. This issue is late again, but I am getting caught up with things. My job has really gotten intense, as we are being held accountable much more in education these days, and that is a good thing, but it does entail many changes and with change comes work. We have some exciting new kits coming down the line, as we will be kitting the NorCal MiniBoots designed by Wayne McFee, which is a 5 Watt amp that works on 20 - 40 meters. Also, Dan Tayloe and Dave Fifield are working furiously on the NorCal 30 kit, for which we shall be accepting orders soon. Check the NorCal page for details on when to order this kit.

I also would like to announce that I have accepted a long standing invitation from my very good friend George Heron to be a speaker at Atlanticon in March. I hope to meet many of the east coast QRPers there. I will also try and get Jim Cates to attend. 72, Doug

Deluxe Direct Conversion Transceiver (Super Sprint Rig)

by Steve Weber, KD1JV

This direct conversion receiver was inspired by Steve Kavanagh, VE3SMA's "Spartan Sprint Special" where he made extensive use of CMOS logic parts to build a small, light weight rig. His circuit was web published by the ARS Sojourner, in I believe, the June issue. You can see his original circuit by going to http://www.natworld.com/ars and rutting around.

VE3SMA's receiver featured a 74HC4053 analog multiplexer as a mixer. I have made a few changes to improve the circuit he shows, by making the output balanced and adding a RF preamp for isolation. I also added a heterodyned VFO circuit, which is built around a 74HC86 XOR gate, because DC receivers work better when the VFO is not on the receiving frequency. I also used a different audio output chain.

The most notable feature of this receiver is that is almost totally immune to SWBCI, even when run on an AC supply. Poor AM rejection is a common problem with DC receivers which use an active mixer, and can be quite annoying. I found a Power Amplifier for the transmitter section could be built that puts out 1.5 watts at 7.5V supply, so this rig is optimized for use with a 7.5 to 9 volt supply, making it ideal to run on AA or C cell batteries.

Circuit description:

The values shown are for a 40 meter receiver.

VFO.

This Heterodying VFO is somewhat unique in that it uses a 74HC86 digital NOR gate as the VFO, cyrstal oscillator and mixer.

The VFO is varactor diode tuned, using 1N4004 diodes. The VFO operates at 4 MHz and has about a 20 KHz tuning range with 5 volts used on the tuning pot. No Doubt a wider tuning range could be achived if "real" varactor tuning diodes were used, but 20 KHz around the QRP frequencies should be enough. A Hartly oscillator configuration is used, using the XOR gate as the inverting amplifier. Some of the output is feed back to the input tuned circuit with a three turn feedback coil. The 100 K resistor connected from the input to the output of the gate biases the gate in it's linear region. The output of this oscillator is quite "dirty" with harmonics reaching well into the VHF region. This is not the kind of VFO you'd want to feed into an analog mixer directly!

Tuning voltage for the tuning control is taken from a separate regulator than used to power the 74HC86. It is shown connected to the +5 volt line in the schematic for convenance. The main reason for this is the regulator was getting pretty warm and caused a fair amount of warm up drift as it got up to temperature. It would also be a good idea NOT to locate the regulator for the 'HC86 too close to the VFO parts, another mistake I made when laying out a board for this circuit.

A Crystal oscillator built using another gate in the 74HC86 package. This is a widely used crystal oscillator circuit.

The VFO and crystal oscillator is then mixed in a third gate of the 74HC86 package. The output of this gate has all manor of frequencies, from various mixing products of the two input signals to harmonics of the input signals. It's quite busy looking on a Spectrum Analyzer! The difference of the two input frequencies is one of the dominet outputs of the gate and the rest of the "junk" is cleaned up nicely by passing the signal through a double tuned band pass filter. Mouser 42IF123 10.7 MHz IF cans are used for the Band pass Filter coils. The current through the input coil of the filter is limited with a 100 ohm resistor, which helps keep the coil from saturating and limits the current from the gate.

MOD: Replace R4, the 100 ohm resistor with 100 pF cap. This reduces current comsumption by 10 ma!

A simple transistor amplifier on the output of the filter brings the output up to about 1 V, p-p. Supply voltage for this amplifier is supplied through an RF choke to keep the noise generated on power supply line by the 74HC86 to a minimum.

A simple jfet amplifier is used as a buffer between the antenna and mixer. Most of the gain of this stage is derived by the step up action of the input tuned circuit. A 10.7 MHz IF can is used for the input circuit, with a 47 pF cap across the tuned coil to lower it down to 7 MHz. These IF cans are more convent to use than winding a torriod, as we don't need a trim cap to tune them. They also take up less space and are better shielded than the so-called "self-shielding" torriod coils. The Mouser 42IF123 cans are usable from 80 to 15 meters, with an appropriate cap added. They can be use with just the internal cap on 30M, an extra cap added, in addition to the internal cap below 30M and with the internal cap removed and an external cap added above 30M.

the June issue of ARS's (Adventure Radio Society) monthly on-line magazine, Steve Kavanagh, VE3SMA published a very interesting rig called the "Spartan Sprint Spe-

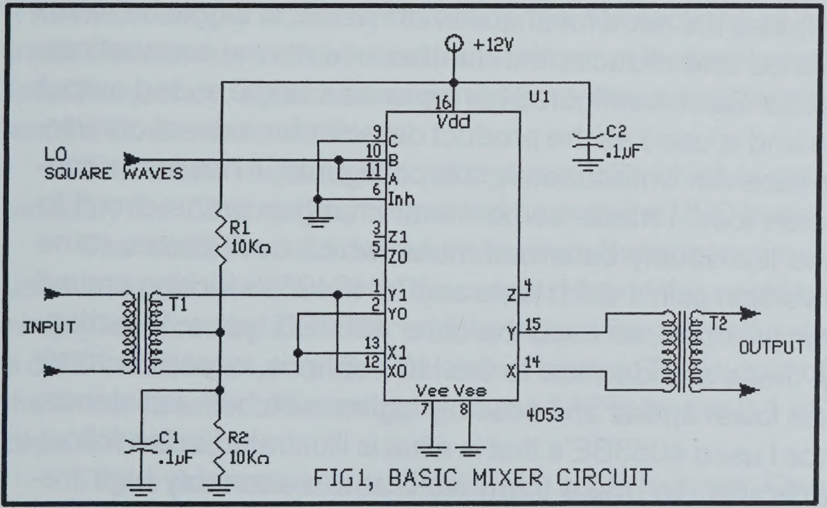


FIG1, BASIC MIXER CIRCUIT

cial". (www.natworld.com/ars/) Steve designed a rig which used many cmos logic parts in a unique way. The part of the rig that struck my interest was his use of a 74HC4053 analog multiplexer switch as a mixer. This mixer is based on the 4066 circuit, who's use as a mixer has been illustrated in various Ham publications over the years. Steve's use of the 4053 simplifies the basic 4066 design, as the 4053 is internally configured as three, single pole - double throw switches. This eliminates the need for an external inverter to toggle between switches and reduces the number of external connections needed. Steve configured his mixer as a single ended output type and is used as the product detector for a direct conversion receiver. Unfortunately, this configuration has some conversion loss. I made some minor changes to the circuit to make it a doubly balanced mixer, which now shows some conversion gain. I didn't have any 74HC4053's kicking around in the junk box, so used the older 4053BE types. Functionally, these are identical to the HC versions, except for their much lower speed and possibly higher switch on resistance. Since I used 4053BE's that is what is illustrated in the following circuits. To make them work at a reasonably high fre-

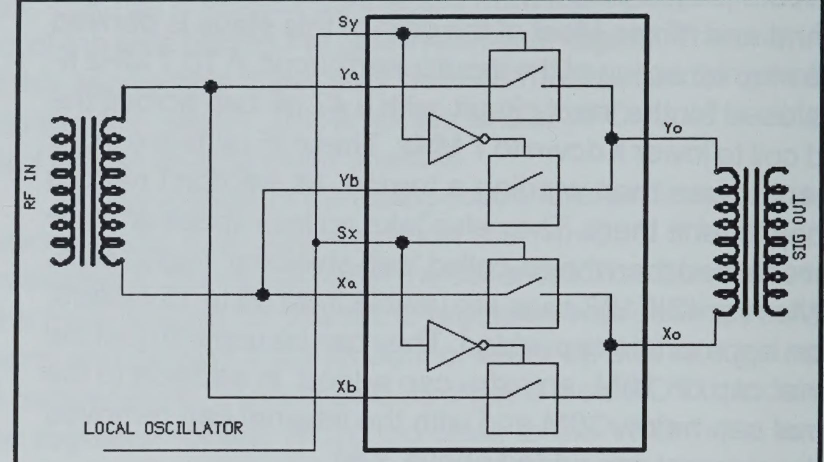


FIG 2 4053 MIXER INTERNAL CONNECTIONS

quency, the supply voltage must be at least 12 volts. With a 12 volt supply, the 4053's will work well up to at least 10 MHz. If higher frequency operation is desired, use a 74HC4053, which will need to be powered by a 5 volt supply.

Here is the basic mixer circuit. R1 and R2 bias the switch gates to 1/2 the supply voltage. The mixer actually works without the bias resistors, but the cap from the center tapped transformer is still needed. The addition of the bias resistors improves the dynamic range of the mixer and the input signal can be quite large, but shouldn't exceed the supply voltage of the chip. The input transformer,T1 can be a trifiller wound torriod, or it can be wound on a small binocular core. Using a binocular core allows for making a turns ratio different than 1:1. This allows making a step up transformer for some passive gain. The output transformer,T2, can also be either a bifiller wound toriod, or wound on a binocular core for a turns ratio different than 1:1. As an audio output product detector, T2 would be an audio transformer. I used a small 600 ohm transformer pulled from an old modem board and it worked well. 1000 pF caps should be added from pins 14 and 15 to ground to by-pass the RF products to ground in this case.

Fig 2 shows the internal connections of the 4053 switch. The mixer simply works by reversing the connections of the input transformer to the output transformer, at the local oscillator frequency. This is exactly the same way a double balanced diode mixer works.

The mixer requires a square wave LO, which is provided by the Q3 amplifier, connected back to the VFO board.

The 4053 Product detector shown in the above circuit uses an audio transformer on the output. I found this could be simply replaced by a resistor and the output feed directly into a differential input amplifier, as shown above. The output of the mixer is rolled off starting at about 1 KHz by the 0.1 uF caps on the output.

There are two main problems with a DC receiver. One is the very wide response of the output. A lot of filtering is needed to get a good CW bandwidth, without hearing everything for +/- 10 KHz on either side of what your trying to hear! The second is Dynamic Range. A lot of audio gain is needed in order to hear reasonably weak signals. But when a strong station is tuned to, it can drive the audio amplifiers into overload and clipping, making it sound raspy.

In order to deal with the second problem, the gain of the receiver is broken up into two sections, with the volume control between them. This way the volume can be turned down before the second gain stage starts to go into limiting.

The output of the first gain stage goes through a 1 KHz roll off low pass filter and then a band pass filter centered on 700 Hz for additional filtering and peaking up the signal at 700 Hz. This is then followed by the volume control and the second gain stage, which also drives a set of headphones. Rail to Rail CMOS op amps are specified in the schematic. This ensues good dynamic range with running of a 7.5 volt supply. The second op amp is a high current output type, so it can easily drive headphones. It would be possible to use a quad op amp for all the audio stages, but using two separate dual op amps will give somewhat better rejection of high frequency signals, as there is some coupling between the amplifier in a quad package due to the common supply voltage and being built on the same die.

Muting for the receiver is done by using the inhibit feature of the '4053, which turns off the gates. This input is active high to mute. Despite the fact the muting is done before all the high gain stages, there is very little pop or "thump". No doubt this is due to the capacitors on the output of the 'HC4053 holding their charge so there isn't a great voltage change when the muting is released.

Transmitter, PA section

This PA section is capable of 1.5 watts out with a 7.5 volt supply and over 2 watts at 9 volts. Efficiency is about

50%. The down side of having this much power at such a low voltage is the current required is pretty hefty, about 500 ma @ 7.5V.

A 2N3904 is used as a driver (typo in the schematic, oops) This drives the trifler wound transformer needed to drive the gates of the push pull amplifier. Common 2N7000 Mosfets are used for the amplifier. The LED, D3 is used to bias the gates at about 1.7 volts. This provides a reasonably stable bias voltage which is about 1/2 the voltage generally needed to turn the fets on. This reduces the p-p drive voltage needed to the fets, but keeps the bias voltage low enough so that we ensure class B operation and not class AB.

The output of the amplifier is coupled through a bifiller wound transformer, with a separate secondary winding to couple to the output filter. The secondary is 9 turns.

The amplifier is keyed on and off by pulling the base resistor of Q3, a 2N3906 low. Another "oops" is there should be a small, 47 or 51 ohm resistor between the emitter of Q3 and the T4, C18, R14 junction. A 3.3 uFd cap should go from this junction to ground. This provides a ramp up/ ramp down switching on the driver transistor for keying wave shaping.

The plastic TO-92 packages of the fets should be heat sinked. This is most easily done by clamping the packages between two piece of aluminum. Layout the fets so the flat sides are both in the same direction. Cut a piece of aluminum long enough to span between the two fets and about 1" tall. Put this against the flat side of the packages. Cut a thinner strip of aluminum to use as the clamp and drill a hole in the center. Bolt the strip to the bigger piece in back.

RIT and Side Tone.

Not shown is a RIT circuit, which is pretty important in a DC rig. One needs to "zero-beat" a station you want to talk to and then move the RIT to tune them in for a sidetone you can copy, one side or the other of zero beat. There is a spare analog switch gate on the 74HC4053. This could be used to switch in a RIT pot and associated limiting resistor. For Side Tone, I figure on adding a Paddle keyer chip which generates a side tone and feeding it into the final amplifier stage.

Building the circuit.

Laying out and making the receiver on printed circuit boards is probably the best way to go about it, if you have the tools and ability to do so. I've been building it up as modules, a VFO module, Rx module, audio module. All on 1.8 x 1.9" boards, which in theory can all be stacked when it's done. SMT parts are used when I have them, to keep things small.

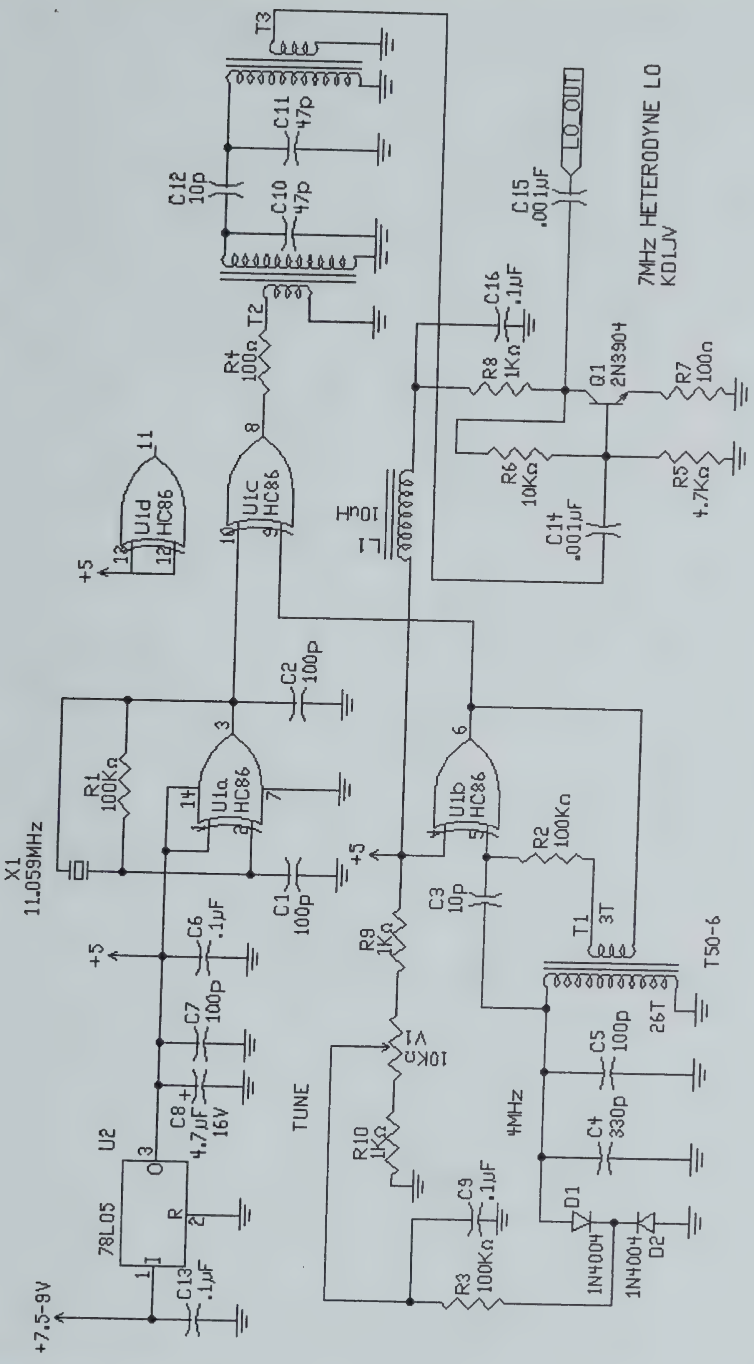
Building it "dead bug" style over ground plane should also work well, and is how the various sections were first built, tested and tweaked. "Manhattan" style would also work, but takes a lot more time and effort in my opinion.

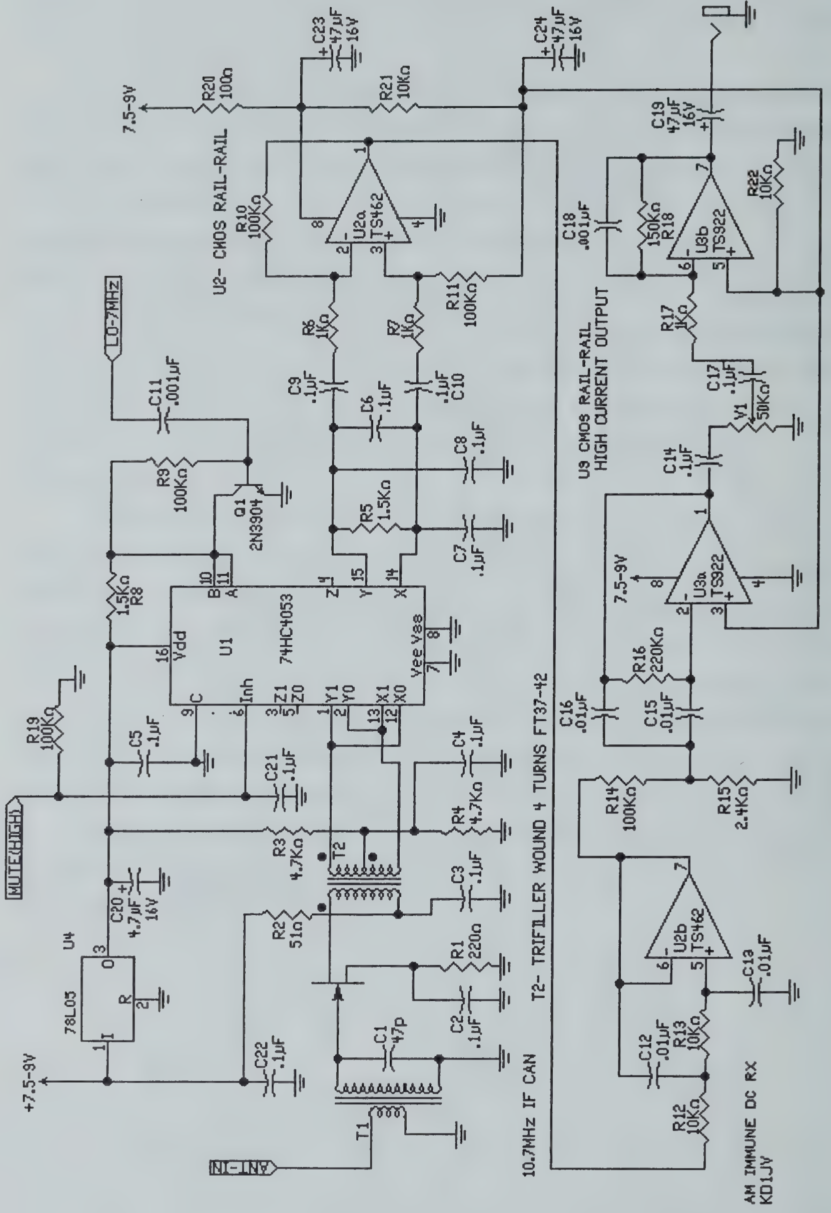
Other Bands:

It should be possible to build this rig for other bands. The mixer has only been tried as shown, taking an intermediate frequency between a higher and lower input frequency for the output. Will have to try it out to see if one can take the sum of two lower frequencies or the difference of two higher frequencies. But the general rule of thumb here will be to keep the VFO as low in frequency as practical and use a higher crystal frequency to move the VFO to the desired band.

I hope you find this circuit interesting and can use some or all of the ideas in your own rig!

72, Steve KD1JV


7MHz HETERODYNE LO
KD1JV



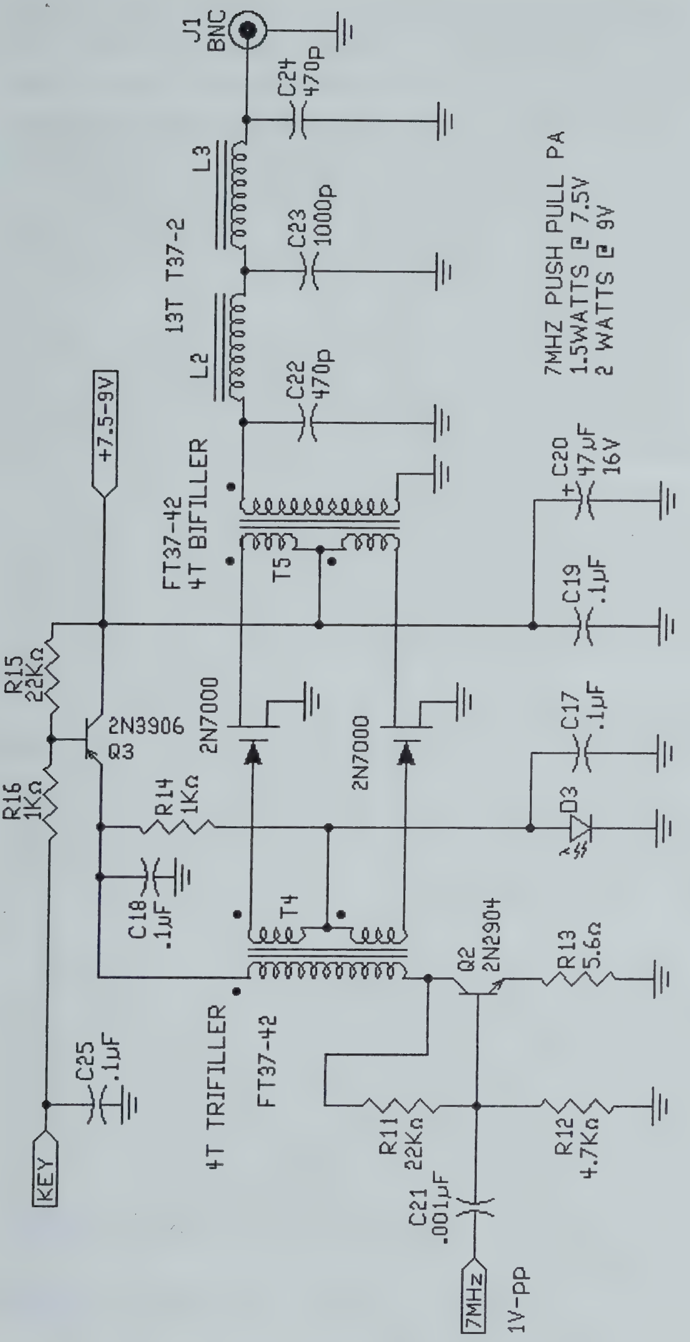
U2- CMOS RAIL-RAIL

10.7MHz IF CAN

T2- TRIFILLER WOUND 4 TURNS FT37-42

U3 CMOS RAIL-RAIL
HIGH CURRENT OUTPUT

AM IMMUNE DC RX
KD1JV


7MHZ PUSH PULL PA
1.5WATTS @ 7.5V
2 WATTS @ 9V

SMK-1 on 20 Meters

By Wayne McFee, NB6M

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Since I have wanted for some time to give the little SMK-1 a try on 20 Meters, and having experimented with and implemented several "mods" that have improved the usefulness of the little rig, I decided it was way past time to see what it would do on the "Big Boys'" band.

Sure, the SMK-1 has long been "out of print", so to speak, as the kit has been unavailable for some time. And, its simple transmitter and receiver circuitry cannot compare to a full-featured rig. But, it is very surprising how well one can do in making contacts with stations both near and far with this little rig, and doing that with something as simple as this is much more exciting and rewarding to all of us in QRP.

Since the SMK-1 is nothing more than a combo of the Tuna Tin II transmitter and MRX40 receiver, and those seem to be timeless in terms of their ability to provide a lot of fun for very little effort and cost, and since there are a lot of SMK-1s out there that may not have been on the air in a while, perhaps a band change or update to a more satisfying frequency range, better receiver sensitivity, or higher transmitter power output would make operating that little rig even more exciting than when it was first offered as a kit.

My objectives in putting the SMK-1 on 20 Meters were to achieve a useful frequency range in both the transmitter and receiver, hopefully the same or near the same in each, that covered the 14.060 Mhz QRP calling frequency; as stable a transmitter signal as possible with enough output to guarantee many contacts; enough sensitivity in the receiver to hear QRP signals well; and to make the band change by using as many of the parts that were shipped with the kit as possible. These goals were met.

Constructed with those guidelines, the 20 Meter SMK-

1, using single crystals in the transmitter and receiver VXOs, covers approximately 14053.5 Khz to 14061.5 Khz. Signal reports on the air have been very favorable in terms of stability, and the transmitter, with a hot 2SC799 in the "easy one Watt Mod", puts out almost two Watts.

To help stabilize both the transmitter and receiver oscillators, and maintain the low parts count, 6 Volts regulated was routed from the on-board 78L06 IC to the tuning circuits. In order to achieve a transmitter tuning range equal to the receiver's, the transmitter oscillator was changed to the configuration outlined in my previous work on extending the transmitter's tuning range. It is necessary to cut two PC board traces in order to accomplish the change.

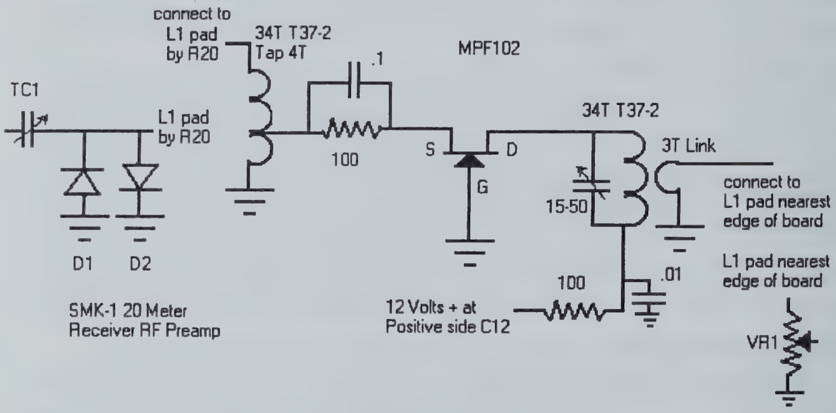
A 10 DB RF preamp was incorporated into the receiver in order to boost its sensitivity to an acceptable level on 20 Meters, while still retaining the same tuned input circuit and diode T/R switching so as to keep the operation of the little rig smooth and simple.

An added benefit of using the already available 6 Volts Regulated to supply the tuning circuits is that only one additional PC board trace needs to be cut, and one extra wire is run from the top of C15 to pin 1 of the 78L06 IC. A comparison of the tuning range in my unit between using 6 volts or 9 volts on the tuning circuits gave surprising results. Very little difference was noted.

A wider tuning range can probably be realized by using larger value inductors in the two oscillator circuits than the 4.7 uH units that I used in this first conversion. I had two surface mount inductors of this value available, even though there is only one in each kit, because of my modifications to other SMK-1s. Further increases in the inductance values would certainly increase the tuning range, but may pull the upper frequency limit below the desired coverage of the 14060 Khz QRP calling frequency.

Although I used all Silver Mica capacitors in the transmitter's output filter, a variety of high quality, 100 Volt rated capacitors can be used with good success. A prime example of why good quality capacitors must be used in the output filter is that in my unit, when I was using lesser quality caps in the output filter while experimenting with it, and while using the 6 Volts regulated to supply the tuning circuits, I experienced a small amount of transmitter chirp, and at first thought that I was going to be forced to use a better regulator than the 78L06, because when I switched to a 9 volt battery to supply the tuning circuits, the chirp disappeared. Additionally, the transmitter output was lower than normal. However, when I went to all Silver Mica caps in the output filter, not only did the chirp disappear but the output came up to where it should be.

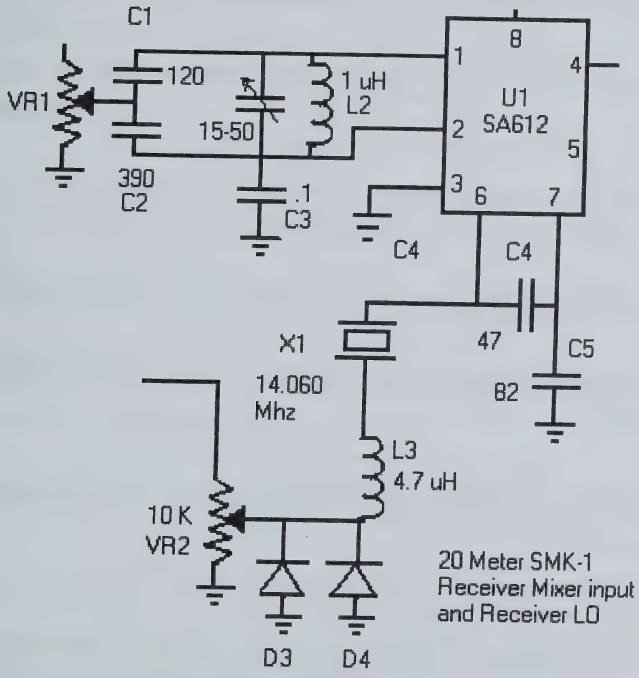
This seems to be a reminder that tuning circuit voltage stability and transmitter PA impedance matching and stability work hand in hand in this rig in affecting the transmitted signal note. I am sure that PA heating also has a negative effect on stability.



SMK-1 20 Meter
Receiver RF Preamp

As mentioned in my prior work on putting the SMK-1 on 80 or 160 meters, converting the rig to another band requires just a few parts changes in the transmitter's output filter network, the receivers input tuning circuits, the crystals and perhaps the feedback capacitor values in both oscillator circuits. Because of the fact that I did not have on hand any surface mount capacitors of the required values to replace the capacitors in the transmitter's output circuit, and wanted to put a toroid coil in place of L5 in order to support the higher output of later modifications, I used all full sized parts in the transmitter output network.

Full sized parts were also used wherever needed in making the band conversion, extended VXO mod, R14 in the PA emitter circuit, now 2.2 Ohms, and in the entire receiver RF preamp, which I built on the inner copper surface of the left side of the PC board case.



20 Meter SMK-1
Receiver Mixer input
and Receiver LO

Wayne NB6M
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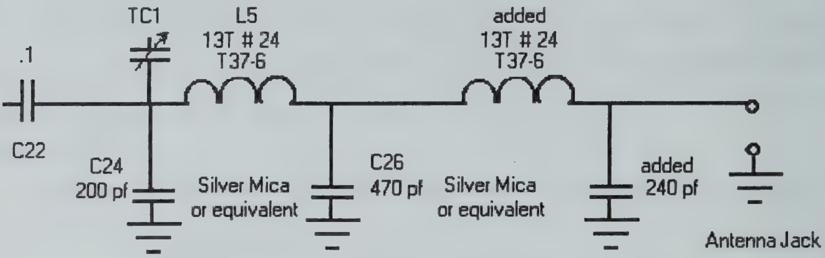
The eight parts needed for the RF preamp are:

34T on T37-2, tapped at 4T	1
.1 bypass cap	1
100 Ohm 1/4W resistor	2
MPF102 or equivalent FET	1
34T on T37-2, with 3T secondary	1
15-50 (or similar value) Trim Cap	1
.01 bypass cap	1



SMK-1 Transmitter Output Filter
modified for 20 Meters

Wayne NB6M Copyright 2002

Fig. 1

20 Meter SMK-1 Receiver RF Preamp And Connections

A stage-by-stage description of the conversion procedure follows:

Make the following changes in the Receiver input circuit:

L1, remove and save for later use.

Build the receiver RF preamp circuit next. It can be built on any available surface of a PC board case, or on a small piece of PC board attached anywhere, if another type of case is used. “Manhattan” style is quick and easy.

Solder a short piece of insulated hookup wire between the L1 pad closest to R20 and the top of the input coil of the Receiver RF Preamp.

Solder a short piece of insulated hookup wire between the top of the output link of the Receiver RF Preamp and the L1 pad closest to the edge of the board.

C1, remove, save for future use, and replace with a 120 pf NP0 cap.

C2, remove, save for future use. Remove C24, 390 pf, and install it at C2.

L2, remove and save for future use. Remove L5, 1 uH, and install it at L2.

Make the following change in the mute circuit:

R5, across Q2, remove and do not replace. Save the 2 Meg removed for future use.

20 Meter SMK-1 Receiver Mixer and Local Oscillator Changes

Make the following changes in the Receiver LO circuit:

C4, remove, save for future use, replace with a 47 pf NP0 cap.

X1, remove, save for future use, replace with a 14.060 Mhz crystal.

L3, remove, save for future use, replace with 34T on T37-2, or a 4.7 uH inductor.

20 Meter SMK-1 Transmitter Output Network Changes

Make the following changes in the Transmitter output filter:

C24, removed in a previous step, replace now with a 200 pf, Silver Mica or equivalent.

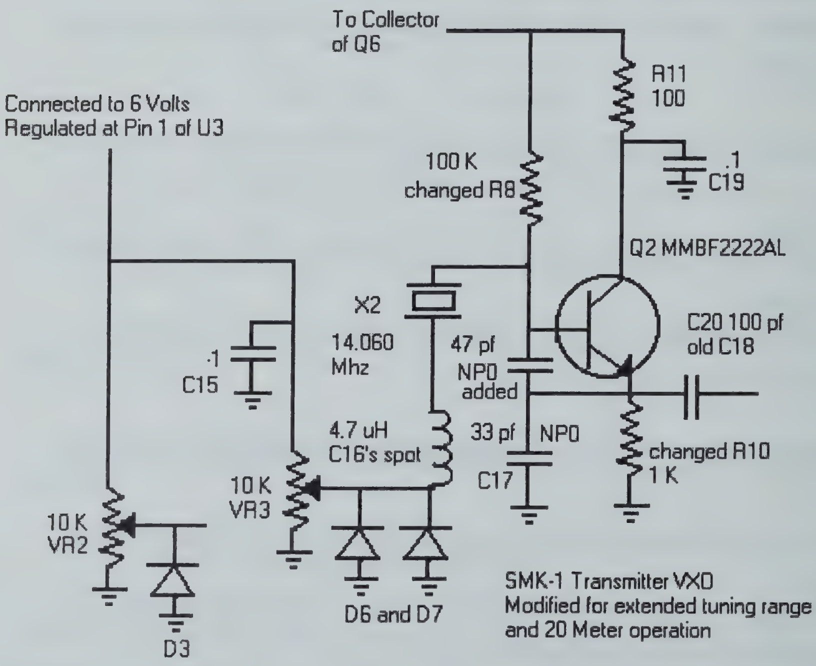
C25, remove, save for future use.

C26, remove, save for future use. If you do not care to put the easy one-watt mod into your rig, replace with a 240 pf, Silver Mica or equivalent.

If you want to add the one Watt Mod, I suggest adding another section of output filter, which will involve the addition of one more T37-6 toroid with 13 turns, and a 470 pf cap will be used to replace C26.

Because I added the second PI section of output filter, I cut the trace between the Ant output connection and C25, ran a short wire from the Ant output connection to the junction of C25 and C22, and connected the added T37-6 toroid between the rear pad of C26 and the top of the added 240 pf capacitor.

This was done in order to move the receiver's RF pickoff point to the input of the TX output filter, so as to make better



SMK-1 Transmitter VXO
Modified for extended tuning range
and 20 Meter operation

Wayne NB6M Copyright 2002

use of its low pass filter characteristics.

If you choose not to do the One Watt Mod, the extra toroid coil is not needed, and the 240 pf capacitor will be used to replace C26.

L5, remove, replace with 13T on T37-6.

20 Meter Transmitter VXO with extended VXO Mod

Make the following changes in the Transmitter VXO circuit:

Remove R9, save for future use and cut the PC board trace between the rear pad for the removed R9 and X2, right at the R9 lettering.

Cut the PC board trace between X2 and C20, between the junction of the trace that goes to L4's pad and C20. We want the trace to still connect from X2 to L4's pad, but not to C20 or the collector of Q2.

C18, remove, save to replace C20.

C17, remove and save for future use. It will be replaced with a 33 pf NP0 cap after the next four steps.

C20, remove, save for future use, replace with the 100 pf removed from C18, but installed at a 45 degree angle, between the left pad for C17 and the rear pad for C20, as viewed from the front of the rig.

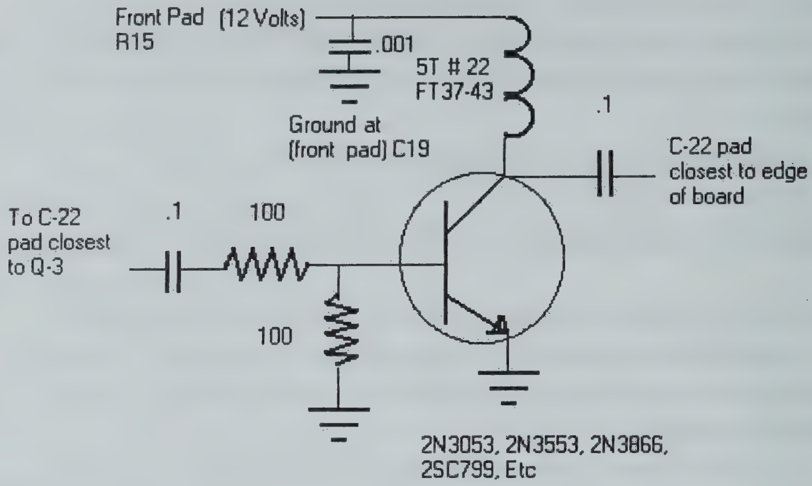
R10, remove and save for later use. It will be replaced after the next step by 1 K ¼ watt resistor.

Add a 47 pf NP0 cap between the base of Q2 and the left pad (closest to Q2) for R10. The base of Q2 is the contact of Q2 closest to X2, on the side of the transistor that has two contacts. This capacitor, along with the 33 pf cap that replaces C17 provide the feedback necessary for Q2 to oscillate.

Install a 1 K ¼ watt resistor in R10's spot.

Install a 33 pf NP0 cap at C17.

L4, remove and save for future use.



Output will depend on transistor used.

Wayne NB6M
2002

Easy 1 Watt Mod for SMK-1

R8, remove, save for future use, and replace with a 100 K Ohm, 1/4 watt resistor.

C16, remove and save for future use. Replace with 34T on T37-2 or a 4.7 uH inductor.

Solder a short piece of insulated hookup wire between the L4 pad nearest C19 and the C20 pad nearest Q2.

Solder a short piece of insulated hookup wire between the L4 pad nearest C20 and the R9 pad nearest X2.

X2, remove, save for future use, and replace with a 14.060 crystal.

You will note that the extra 9.1 Volt Zener and associated parts added to the VXO oscillator circuit in the original Extended VXO Mod are not used here, as it was determined that they did not add to the stability of the circuit.

Make the following changes to the tuning circuitry:

Cut the PC board 12 Volt trace between the printed copyright “C” and C15.

Solder a short piece of either insulated hookup wire or cut off part lead between the end of C15 closest to R8 and pin 1 of the 78L06, U1.

If you care to add the easy One Watt Mod, do the following:

You need the following parts to do the mod, plus the 13T T37-6 and the 470 pf cap mentioned earlier in the changes to the TX output circuit:

two - .1 uf disc or monolithic, etc (bypass cap)
two - 100 ohm resistors
one - RF transistor of your choice
one - roughly 10 uh, RF choke, FT37-43 toroid with 5 turns # 24 (or similar gauge)
one - .001 bypass cap

I did the mod "ugly" style with all leaded parts, soldering the necessary leads to the pads on the board. Here is what you do:

I suggest you read all the instructions first, to get an understanding of the mod, before proceeding with the actual work.

First, remove C22 from the board. (I used two soldering irons, quick and easy)(save it)

Cut one lead of one of the .1 caps so as to leave about ¼", bend a 90 degree angle about 1/8" from the end of that lead, and solder that lead to the C22 pad closest to the edge of the board. Leave the other lead long for a moment.

Cut one lead of the other .1 cap so as to leave about ¼", bend a 90 degree angle about 1/8" from the end of that lead, and solder that lead to the C22 pad closest to Q3. Leave the other lead long for a moment.

Cut one lead of a 100 Ohm resistor so as to leave about 1/4", bend a 90 degree angle at 1/8" from the end of the short lead, and solder that lead to the ground pad of R14.

The idea is to have the resistor standing just about straight up, maybe leaning just a little bit towards Q3. By the way, the ground end of R14 is the pad right at the edge of the board.

Now, using short leads on all three parts, solder the other 100 Ohm resistor between the free lead of the first 100 Ohm resistor and the free lead of the .1 Cap that comes from the C 22 pad closest to Q3.

What we are doing here is providing a coupling capacitor from the output of T1 to the base of the Final Amp we are going to install. The two 100 Ohm resistors form a divider network so as to provide about 2 Volts RF on the base of the Final Amp. The 4 Volts or so right from the output of T1 is way too much drive for the Final Amp and output network we are using, and if we drove it with that much RF, it would overheat and probably self destruct in a short while.

So, at this point you should have a .1 from the C22 pad closest to Q3, connected to a 100 Ohm resistor, which is connected to another 100 Ohm resistor, which is connected to ground.

Position your RF transistor above the existing PA transistor, with the emitter lead towards the edge of the board, the base lead towards the rear of the board, and the collector lead towards the center of the board.

We want the emitter lead to be as short as possible, but the other leads, the body of the transistor and any heat sink used will need to clear the other parts. Remember, the body of the transistor, and therefore the heat sink as well, are connected to the collector, and have both 12 Volts and RF on them. We can't allow the heat sink or transistor body to come in contact with any other parts or with ground. With this in mind, take note of how long the emitter lead will need to be in order to solder it to ground at the ground side of R14. Cut the lead to that length.

Bend the base and collector leads out to their respective sides of the transistor, close to the transistor body. Leaving the emitter lead pointing pretty much straight down, only slightly bent out towards its edge of the transistor body, bend an eighth of an inch of the lead over at a 90 degree angle, and solder the emitter lead to ground at the pads of R13 and C18 closest to the edge of the board.

Cut the base lead so that it will reach the junction of the two 100 Ohm resistors, and solder it there.

Wind 5 turns of #24 (you could use small insulated wire for this if you don't like scraping the ends of magnet wire) on the FT37-43 core. Scrape about 1/8" of wire clean of insulation at the end of each coil lead.

(This is meant to be about a 10 uh RF Choke. If you don't have an FT37-43, you could use any combination of core and number of turns that gives you roughly that figure. Suggestions are: 35 turns # 22 on T68-2, or 43 turns # 28 on T50-2, to name two.)(Or use a 10 uh RF choke)

The RF choke for the new final amp sits right above R15 and R19 on the board. It should be oriented so that the toroid is at a 90 degree angle from T1 in order to minimize coupling between the two. The two leads from the RF choke should be about 3/8" long.

Before you install the RF choke, solder the .001 bypass cap in place between the 12 volt side of R15 and the ground side of C19. The proper pads of these parts are those that are closest to the front of the PC board.

Then, solder one lead of the RF choke to the 12 Volt side of R15 (front pad). This is just a convenient spot to pick up 12 volts.

Solder the other lead of the RF choke to the Collector of your RF transistor. Check the lead lengths of the two and adjust accordingly before soldering them together.

Now, the free lead of the the .1 uf Cap already soldered to the C22 pad closest to the edge of the board is soldered to the collector of your RF transistor. Check for appropriate lead length, cut the lead, and solder it in place.

You should place a heat sink on your new final RF Amp transistor.

I added a second PI section to the output filter, by replacing C26 with a 470 pf cap, glued a Manhattan style pad (with 5 Minute Epoxy) to a convenient surface of the rear of the PC board case, unsoldered the antenna lead from the center of the antenna jack on the case, soldered that lead to the Manhattan style pad, soldering one lead of a 13T, T37-6 toroid to the Manhattan style pad, the other end of that toroid to one lead of a 240 pf cap, the other lead of that cap to ground, and connected the junction of the 240 pf cap and the added toroid to the antenna connector on the case of the rig.

The amount of transmitter output will vary, depending on the type of RF transistor used. I got .85 watts out with a 2N3053, and with a hot 2SC799 got almost 2 Watts out. Your mileage will vary.

Tuneup:

When the rig is powered up again, TC1, the trimmer in the RF Preamp output, and TC2 will need to be retuned for highest received signal level. With the values given, very definite peaks should be had on each trimmer. They may need to be retouched a couple of times to ensure they are properly tuned.

Summary:

The drawings included show the circuit details of the added receiver RF preamp, and all the parts changes necessary to convert the SMK-1 to 20 Meters. At first glance, it might seem like quite a bit of work to make the conversion. However, each phase is easily accomplished, and the results are quite pleasing and well worth the effort.

As always, two low-wattage soldering irons and a damp cloth are essential for removing and saving surface mount parts. I use a jeweler's headband type magnifier and strong light whenever I am working with any surface mount project.

The receiver's ten DB RF preamp brings signal levels up nicely, and is not found to overload the SA612 mixer. No switch was provided for removing the preamp from the circuit as the RF gain works quite well to reduce receiver gain whenever appropriate. R5, the sidetone pathway across the receiver's muting transistor, Q1, was removed and not replaced. With the RF Preamp in place, there is enough leakage of the TX signal across Q1 that the sidetone is quite audible at any reasonable gain setting, and is actually just a little too loud at the maximum RF gain setting. A 4.7 Meg Ohm resistor was put in R5's spot as an experiment, but was not sufficient resistance to lower the sidetone to a comfortable level at high RF gain settings.

I have added an 800 Hz active audio filter to the output of the LM386 in my SMK5Watt 40 Meter rig, which can be switched in or out as desired, and have been so pleased with the available selectivity that I plan to add one to this rig as well. It will be particularly useful in helping the receiver reject nearby strong signals, as well as getting rid of the high pitched QRM of signals further away and elevating the chosen signal above the noise level.

On the air results with the little rig, even at the half-watt level, have been very satisfying. The first QSO with the little rig was with Ricardo, XE2RN/QRP, in La Paz, Mexico, who was running 5 Watts and was Q5 and a good strength 7. I was especially pleased with the contact, as La Paz is one of my favorite ports in the Sea of Cortez, which I visit regularly in my sailboat.

Another QSO of note was with Don, K5QK, in Louisiana who reduced his transmitter power to 500 Milliwatts to match the output of the SMK20, and his signal was still Q5 and solid copy during the remainder of the contact, which lasted several minutes longer. This speaks well of the sensitivity of the receiver.

Since those first contacts, I have added the easy One Watt Mod to the rig, and now have over 1.5 Watts of output, which is enough power to guarantee contacts any time the band is open.

Further experimentation is in order using dual crystals in the VXO, and perhaps changes in the inductance values used in series with the crystals, in order to optimize the frequency range and band coverage.

Future additions to the SMK20 will include the audio filter mentioned, a Tick keyer, and, at a later date, perhaps the 5 Watt Mod. For now, I am enjoying operating the rig at the one watt, plus, level and have continued racking up the contacts.

As mentioned above, any or all of these modifications to the SMK-1 can easily be applied to the Tuna Tin II and similar transmitters, as well as the MRX40 and other types of receivers, with corresponding benefits.

I hope to see you one the air around 14.060 Mhz.

Enjoy.
Wayne NB6M

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Introduction to the Electroluminescent Receiver

By David White, WN5Y

It seems that as Hams get older, the boards get smaller. I thought a receiver made from an NE602 portable phone chip was small until I saw English kits to “learn about Surface Mount Technique.” The curves have crossed and it’s time for an upturn. So I designed a competition grade receiver for the Ham band, or any bands, on two huge screened boards (8 ½” by 8 ½”) that you can cut down to six really big ones if you insist. The interconnections are infrared and there are 21 functional LEDs that add to the circuit, not just tell you when it's on.

I can show you how to make an LED DBM that will make your eyes hurt if you stare at it, like a 6V6, too. And this radio has all the audio the average ham can use.

This introduction will explain the LEDs, give a circuit description, discuss highlights of each board, and list the design features that help build the kit.

Why the LEDs?

The LEDs are used for diagnosis, indicators, and visual inspection of oscillator injection levels. All the current of the MOSFET circuit travels through the LED. Therefore, mistakes in the MOSFET circuit show in the brightness of the LED. After building a "dead bug" prototype, I discovered that I had not touched the oscilloscope. The LEDs with the amplifiers and mixers are used for diagnosis. The amplifier LEDs flow 5 mA and the LEDs on the variable gain amplifiers will go dark as the gain of the amplifier is turned down. An LED very bright, dim, or off means inspection of the circuit for errors. The mixer LEDs diagnoses the oscillator/amplifier chain. Gate 2 of the MOSFETs is at .5 volt, which turns off the device, and only when oscillator injection is present, will the LED turn on. The LEDs give a visual indication of oscillation injection levels that are easy to gauge and reset. Indicator LEDs are used at the bandpass and crystal filters, VFO, and crystal oscillator. Super-brights can be used in many of the locations to increase the visual impact of the receiver.

Circuit Description

The receiver is a dual dual-conversion, dual dual-image superhet receiver. The switching IF's are dual imaged with a high side LO, using a relay switched Tesla VFO [1]. The IF frequencies are 455 KHz apart, allowing conversion to a 455 KHz tail end IF strip. Bands covered are 40/20 Meters (with the 3.547 MHz IF), and 30/17 Meters (with the

4.000 MHz IF). A RF amplifier sends signals through a varicap tuned bandpass filter [2], to the first mixer, and out through a ladder crystal filter to the second mixer. A crystal oscillator, switched by a crystal filter IRED, secures a 455 KHz output from the second mixer to the 455KHz IF strip. AGC controls signal levels to a Schottky diode ring product detector, yielding audio with a 455 KHz tunable BFO and amplifier. An adjustable gain pre-audio amplifier drives a TDA2002, an 8-watt car audio amplifier. The VFO is tuned with a five-section variable capacitor, making bandspread changes easy. The receiver comfortably tunes the lower 150 KHz of the 40/20 Meter bands and all of the 30/17 Meters bands without the use of a reduction drive. VFO frequencies are 14 MHz (30/17), 10.545 MHz (40), and 10.455 (20).

First PCB Board

The first board features the front end of the receiver: input section, VFO section, and first mixer/crystal filter section. The highlights of this board are the RF amplifier, variable bandpass filters, and the first mixer. Also, the control center for the infrared switching is located at the input of the crystal filter. The best high-level RF amplifier ever designed, the post-mixer amplifier for the Progressive Communications Receiver [3], is used as the RF Amplifier. The Bandpass filters [2] tune 4.4 MHz to 21 MHz. A 50K pot tunes both bandpass filters, with relay switching, controlled by IR (infrared) devices to improve input/output isolation. The first mixer is a four MOSFET mixer/amplifier combination. Gain is approximately 14 dB with adjustable sensitivity and dynamic range. As VFO injection is increased, by a 100K pot at the first VFO amplifier, the sensitivity of the mixer is increased and dynamic range decreased. This allows the receiver's sensitivity and dynamic range to be varied according to the antenna used and band conditions. Two ladder crystal filters [4] finish the first board. The input switching of the crystal filters is the control center for the Infrared band switching of the receiver. A high power IRED [5], at the 4.000 MHz filter, turns on a Phototransistor at the Crystal Oscillator so the output of the Second Mixer is always 455 KHz. Another high power IRED is switched on at the 3.547 MHz filter that controls the VFO frequencies. The IRED switches on a 10.545 VFO relay, which turns the receiver to 40 Meters. This same Phototransistor, located between the VFO amplifiers, gives power to a 10.455 VFO relay, which is switched on by a Photodiode activated by an IRED when the 20 Bandpass filter is selected. This action turns the receiver on for 20 Meter reception.

Second PCB Board

The second board features the second mixer, crystal oscillator and amplifier, 455 KHz IF strip with AGC, product detector, BFO and BFO amplifier, and two audio amplifiers. The highlights of the second board are flashing IF strip LEDs, S-meter flexibility, and two gain adjust points to control the audio level. There are two AGC controlled 455 KHz IF amplifiers, and one 455 KHz amplifier for the AGC detector. The LEDs of the two AGC controlled amplifiers will flash with the level of the received signal providing a built in S-Meter. The LEDs will be brightest when the MOSFET's Gate 2 voltage is 6 volts (no AGC) and off at 0 volts. An S-Meter output was provided, and the circuit can be adjusted for meter movements from 50uA up to 500MA. It is highly active, so weak signal reception can be aided with the S-Meter. The variable gain BFO MOSFET amplifier sets the injection level to the product detector. Running this amplifier at it lowest level, with the LED just barely on produces the quietist receiver. An adjustable gain pre-audio amplifier follows the product detector output filter. A "Gain Adjust" emitter bypass capacitor [6] is marked on the board to adjust the drive to the TDA2002. No capacitor is good for home use, a 2.2 mfd in a noisy environment. The excitement of this board is the AGC controlled LEDs, (that flash along with CW signals), adjustable audio amplification, and I almost forgot, an LED DBM that you better not stare at with the bare eye. Replace the four Schottky diodes at the product detector with Super-Bright LEDs (blue is my favorite), raise the value of the coupling capacitors (BFO out -3.3pf to 100pf, amp out - 47pf to .01), and stand back. Have your sunglasses handy.

Building Aids

The PCB is a single sided design, the traces are .50" wide. All the soldering points were enlarged while trying to keep soldering bridges to a minimum. Solder checks are done by looking for light shinning through a hole, which means a missed soldering point, or an incomplete soldering job. Without a solder mask, solder has plenty of room to flow properly, giving a smooth appearance and easy identification of bad joints. Each board is three sections, with holes defining each section, giving six smaller PCB boards, which can be individually shielded in PCB boxes. Or small shields can be installed along the holes. The mounting holes in the PCB boards are aligned for easy stacking, either whole or split apart. The topside of the board has a complete silkscreen, for easy location of parts. Important instructions are silkscreened on the board, so a hurried person would not miss important points. The most common parts, 95 .01 caps, 32 100K resistors, and 28 100 ohm resistors, all have the part number inside the footprint for easy identification. Spend two hours stuffing the parts, the boards will look half-done, and give the inspiration to keep going on to completion. Each board takes about 6 hours to complete. Instructions are on a CD-ROM, which allowed plenty of pictures and thorough instructions. The receiver is designed to work without a case. In place of a case, an unetched PCB bottom plate is included for mounting the boards, and mounting all the connectors for

B+, speaker, and antenna. The main tuning capacitor has a solderable frame and is soldered on the bottom side of the PCB, underneath the VFO, for a very sturdy and stable mounting.

Conclusion

It is time to put a kit together that you can see, easily place parts, and have the freedom to modify and improve without major hassles. The result is a very good receiver that can be a working base for experiments, improvements and learning. The LEDs bring important contributions, but after the receiver is working, also contribute to an exciting look. Saving 500 mA on a desk lamp is another option. With the large board sizes, and distinct outlines of each individual circuit, it is an extensive, but easy kit to put together, while familiarizing you with the circuits that make the receiver "bring in the signals".

Footnotes:

[1] The name for the VFO, "Tesla Oscillator", comes from the April 1999 issue of QRP Quarterly, Chris Trask, N7ZWY, "LC Oscillators - A Brief History". The more common name for the VFO is the Vackar VFO.

[2] September/October 2000 issue of QEX, "Narrow Band-Pass Filters for HF", by William Sabin.

[3] Wes Hayward, W7ZOI, and John Lawson, K5IRK, "A Progressive Communications Receiver," QST, November 1981, Page 11.

[4] "Designing and Building Simple Crystal Filters", by Wes Hayward, W7ZOI, July 1987, QST, Page 24

[5] Individual IREDs are part number LED1067, Page 8. (T-1 ¾", 1.3V, 1A peak, 100mA continuous, 940nm, 16 degree viewing angle, clear package). BG Micro at http://www.bgmicro.com

[6] http://www.rason.org/Projects/bipolamp/bipolamp.htm This site is all about audio amplifiers, and the kit pre-audio ampli-

fier was designed from the information here. The Electroluminescent Receiver kit web site is at http://www.nwtexas.com/usr/r/receivers or http://www.ai.com/receivers The price of the kit is $89.95 plus shipping. Ordering information is on-line at http://www.nwtexas.com/usr/receivers/elrorderinfo.htm, or http://www.ai.com/receivers/elrorderinfo.htm or write to David White, P.O. Box 71, Pampa, Texas 79066-0071. Email: wn5y@yahoo.com

QRP To The Field 2002: Water World Deja Vú

by Jan Medley, N0QT, NorCal Contest Manager

Marine Mobile Stations

Call	Pts	SPC	Loc	FINAL
W5KID	1275	45	5	286,875
NQ4RP	1080	42	5	226,800
KG6ECI	590	55	5	162,250
N3AO	390	28	5	54,600

Ocean Stations

Call	Pts	SPC	Loc	FINAL
K0ZK	1035	56	4	231,840
K2QO	795	44	4	139,920
W3CD	580	32	4	74,240
N9WW	350	21	4	29,400
AD6JV	400	18	4	28,800
AL0HA	190	11	4	8,360
K5MGJ	20	2	4	160

Other Waters Stations

Call	Pts	SPC	Loc	FINAL
K5OJ	1700	67	3	341,700
N4DD	1440	63	3	272,160
KI0II	1045	53	3	166,155
WU0L	1200	41	3	147,600

K4JSI	745	40	3	89,400
W3IYQ	815	31	3	75,795
W0UFO	745	32	3	71,520
KN5TX	650	32	3	62,400
NK7M	520	33	3	51,480
W1PID	1165	10	3	34,950
K3WW	390	24	3	28,080
W5TB	425	21	3	26,775
NA5N	295	22	3	19,470
N7CEE	285	21	3	17,955
W3ANX	235	18	3	12,690
NN5E	245	11	3	8,085
KV2X	205	13	3	7,995
N0QT	130	9	3	3,510
VE6QRP	135	8	3	3,240
K5HWT	75	4	3	900
W1QHG	40	3	3	360

Field Stations

Call	Pts	SPC	Loc	FINAL
W4GGM	780	46	2	71,760
N6WG	615	28	2	34,440
WD7Y	570	30	2	34,200
AD6GI	490	23	2	22,540
WA4CIT	375	22	2	16,500
KW4JS	235	15	2	7,050
W1OH	230	13	2	5,980
JR1NKN	130	3	2	780 (JA DX)

Home Stations

Call	Pts	SPC	Loc	FINAL
K5KW	1380	50	1	69,000
K7TQ	1220	49	1	59,780
K8CV	405	20	1	8,100
HP1AC	320	21	1	6,720
NQ7X	305	22	1	6,710
K8HJ	225	13	1	2,925
VE5RC	200	10	1	2,000

Check Logs: K7GT, N8WE

AD6GI: Heavy rain, drizzle, scattered clouds and sunshine at various times. Only needed snow and sleet to complete the list. Several reports on the reflectors showed others getting that part, though. Great plans to do WT and all set to go, when heavy rain started. Plan B put into action. Still had a great time and am ready for next TTF. Tnx to those giving me a call. 'Tis much appreciated.
[K2; PW-1 on tripod]

AD6JV: Great fun as usual!
[K2; ??????]

AL0HA: Food, fun, fellowship and onlookers KH6IMB, KH6BMM, W6ORS, AH6NK, KH6AFQ, KH6FKG, NH7D, KH7SO, KH6JRM, KH7FV, WH6LU, AH7G, NH6OW, AH7A); we celebrated the 10th Annual Moku Ola Island DXpedition 27 April, 2002 with AL0HA call.
[K2; vertical quad loop]
{uh-huh, sure...this was a PARTY not a Dxped! I saw the site permits...you ain't foolin' me! - Ed.}

HP1AC: [IC-706MkIIG; TA33JR]

JR1NKN: Went to a park on top of a hill by bicycle early in the morning. Very happy to have QSOs with stations in the states in the contest. I was excited and had a fun (time).
[FT-817; loop]

K0ZK: You have to read the "Tale of the Salty Dog"...what fun! -Ed. [K2; 25' vertical w/#22 wire radial into salt water]

K2QO: We (Mark, K2QO and John, W2IV) had a great time operating from the shores of Lake Erie near Angola. We used

an FT-817 and LDG QRP tuner. We'd previously fiddled with a compact 3-band yagi, but its performance was no match for a doublet high over the lake. The marine battery was overkill. Next time we'll go with a couple 7Ah gel cells.
[FT-817, 66' doublet]

K3WW: I have several ponds and a spring and springhouse in my back yard, and operated from my gazebo, where I can watch the fish and ducks.
[K2; 300 ohm-fed dipole ala QST a few months ago]

K4JSI: As always, I thoroughly enjoyed QRPTTF, this being my fifth outing.
[Ten Tec Argo 556; 20m half-square end fed]

K5HWT: [SW-20; dipole up 25' on DK9SQ pole]

K5KW: Twenty was clearly the band of choice in my area. Plans to operate Class WT fell thru at the last minute, so made do at home. Great fun!
[IC-756 Pro; G5RV]

K5MGJ: This was my first field op and I was on a business trip and only had about an hour to operate. It's only 3 QSOs, but they were hard-fought and a joy to get. The lighthouse keeper was kind enough to walk my camera up to the top of the lighthouse to snap the photo.
[FT-817; MP-1 vertical]

K5OJ: Conditions a little better than last year. Lots of curious visitors this year. Thanks for the fun! [K1 x2, K2 x2; 10m stacked dipoles, 15m stacked dipoles, 20m 2-ele yagi, 40m dipole & vertical]

K7GT: Not bad for 2-1/2 hours! Stinko wx and a head cold

kept me at home this year. Took breaks and worked on the new operating console.
[Omni 6, DX77 vertical]

K7TQ: [K2; Force 12 C4S]

K8HJ: [S&S Ark-40; dipole]

KG6ECI: [K2; long wire]

KI0II: That was fun in the sun and wind. Setup at a picnic area on top of the dam at Chatfield Reservoir (CO), and (watched) sailboats battling the white caps (while) trying to keep track of my paper log blowing in the wind. [none given]

KN5TX: Had a great time on the banks of the Sloan Creek Tributary. Food was great, company was superb and weather was typical Texas - cloudy and humid, then sunny, then steamy with lots of caterpillars. Bands were not in real good shape, but adequate. Most productive was 20m. Looking forward to doing it again next year. [none given]

KW4JS: I had lots of fun in 2 hours - not bad for rain and a new 4-week-old harmonic (son). Thanks to everyone! [K2; random wire]

N0QT: Did I mention the wind? [FT-817; Hustler verticals]

N3AO: Really had fun - great contest! Great wx too. Some really strong sigs. A frog jumped into my canoe! [K1; inv vee]

N4DD: Our operation was conducted at Bays Mountain Park and Planetarium. Equipment included a K2 with autotuner and 40m dipole. We also utilized the QRPDUPE logging software. Operators were Dennis (N4DD), Luther (N4UW), and Dan (N4ROA). [K2; 40m dipole]

N6WG: Conditions were pretty thin out here on the left coast. Worked everything I heard. Had a great time, though temp was more appropriate to FYBO. [K2, 40m dipole]

N7CEE: Plans to operate from a sailboat on a central Arizona lake were scuttled at the last minute due to winds, so Friday afternoon I set up near a spring in the Mogollon Rim Country. A short but very windy storm hit that evening, but much to my amazement the #26 wire antennas were still up. Signals were down and the pace slow at my location, so I alternated reading with contesting. Per NA5N's suggestion, I checked 10m on the hour, and others seemed to be doing the same. Great idea, Paul! I'm looking forward to next year's theme. [K1; 270' horizontal loop, 170' end-fed wire]

N8WE: [SW-20; auto whip mounted on plastic auto hub cap]

N9WW: Weather deteriorated dramatically and I ended up operating from the car for much of the contest. Wire antenna was tossed into trees above my operating position and a counterpoise was run along the curb. Glad to give out the "OC" to all I worked. The lakefront is only about 2 miles from my home QTH and I should operate from the park more often when the weather is good. If only it were salt water... Thanks for organizing a fun contest - I'm psyched for this summer! [K1; 75' end-fed wire up 25']

NA5N: Did I mention the wind? [FT-817; Spider vertical]

NK7M: Most fun this year! Even with poor antenna set up. Heard lots of sigs, made good contacts. [K2; random wire]

NN5E: My first QRPTTF, but I didn't have much time to operate. Also my first outing with K2 #2234. I'm still tweaking it but audio filter and ATU seemed to work. Only worried about the 554 report, hope I didn't sound that bad! [K2; MP-1]

NQ4RP: The promise of hot activity on 10/15 didn't pan out...in fact, all bands were pretty crummy. Still, we worked 42 SPC/bands for 30 states 2 VE and Panama. After 5 hours, getting a QSO seemed like work, so we hung it up. Especially fun to work W5KID and AJ4AY, and Knightlights Club, WQ4RP. [K2 x 2; 300' long wire, SLV, W3EDP long wire]

NQ7X: [TS850s; 3-el triband beam]

VE5RC: Thanks for a nice contest. Maybe I'll work you next year from Wascana Lake, too cold this year! Hi! Luv my new K2! [K2; 2-el tribander]

VE6QRP: [none given]

WØUFO: Worse than FYBO...snow, rain, cold wind...but, of course, fun! Got cold and wet so never worked 40m as planned, nice to hear everyone.
[MS-15, NC-20; 40m dipole, zepp]

W1OH: Had a good time; set up on the grounds at Woods Hole Oceanographic Institution (where I work); about 1/4 mile from Vinyard Sound, so called it a FD operation since I couldn't see water from the newly cleared formal garden (part of the old estate where the Institution buildings are now). Nice sunny, cool day! [Sierra; Norcal doublet & BLT]

W1PID: I rode my bicycle several miles to an isolated spot on the Pemigawassett River in Sanbornton NH. A perfectly beautiful spot. Bands were disappointing. Not as much activity as I expected. Still had a fantastic time. Thanks to all for the contacts. [DSW-40, DSW-20; dipole]

W1QHG: Safety violation? Did antenna work with 5-month-old baby in one arm? Operated alongside Red Maple Swamp. [K1; wire and counterpoise]

W3ANX: Good wx - suffered from switcher p/s hash from logging PC! A good shakedown for FD in June...Now to get a better antenna, and fix the hash problem.... [K2; St. Louis Vertical]

W3CD: I found a slightly better site which was more removed from general foot traffic. It was a great RF location and offered spectacular views of the Bay area. When the action got slow, all I had to do was look to my left for a pleasant divertissement! [K2; 20' vertical, mesh fence counterpoise]

W3IQY: Great time at Brandywine Park. Always enjoy QRPTTF. [K1, Sierra; 100' CF Zepp]

W4GGM: A Maury Amateur Radio Club effort! Wx looked bad but only got rained on a few minutes and the ticks weren't as bad as expected. It was fun playing radio on a 30-acre hill. See y'all next year. [K2, K1, FT-900; 40m dipole, 20m dipole]

W5KID: Great pics of the USS Kidd, DD-661 in Baton Rouge LA.

W5TB: Thanks to all, always a fun time. [K1; 40+ ft long wire]

WA4CIT: My first attempt at this contest. What fun! I was surprised how quiet 40 meters was, especially during the first couple of hours. [none given]

WD7Y: Much better results than last year, but nothing to shout about. I was hopeful for 60 or more QSOs but only to wind up with 48. Maybe conditions were poor again, I wasn't able to work one station on 10m. I have worked QRPTTF for the last five years and always enjoyed the event, this year may not have been a banner year but still had a wonderful time. [K2; 135' zepp]

WU0L: Thanks for a great contest. It was a beautiful day in the Colorado mountains. [Self-design homebrew 40/20; G5RV]

W6QIF Oscillator

by

Jim Pepper, W6QIF

I have always been interested in oscillators.(1) They are the very heart of both the receiver and transmitter. There are several things that are important to their operation, i.e. their frequency stability which includes their temperature stability, the method of tuning the circuit, the mechanical stability, the effect of loading on the circuit and purity of signal.

Being mainly concerned with the frequency stability as a function of temperature, I decided to build a crude oven where I could place various components of the oscillator to see how they were affected by varying the temperature. The oven consisted of a cardboard box lined with styrofoam for insulation. The heater element was a 25 watt 25 ohm resistor connected to a 12vac source dissipating about 5 watts. I used a digital thermometer to record the temperature.

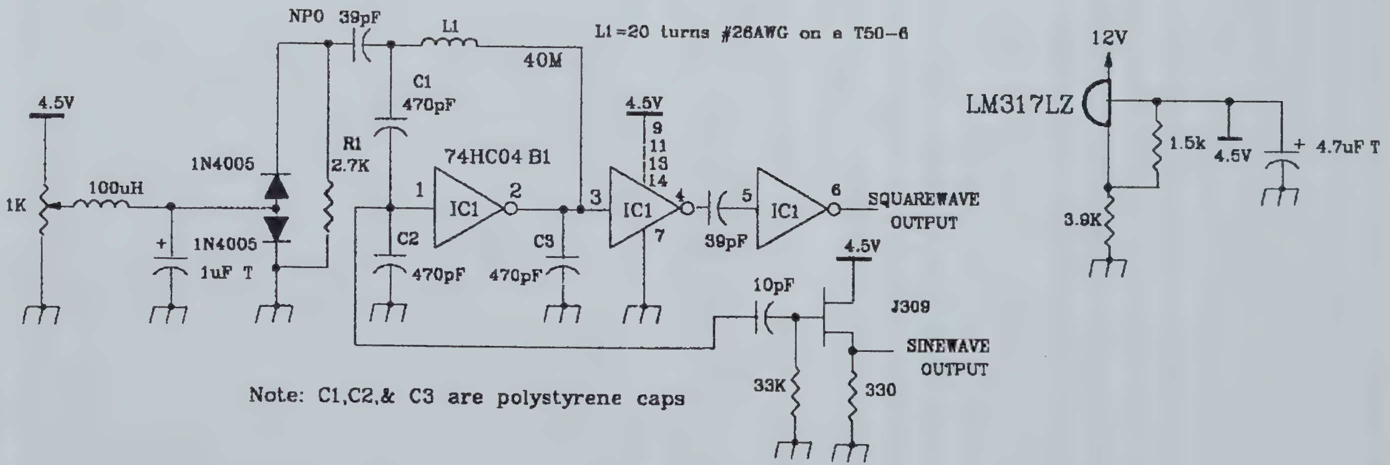
I previously had tested COG and NPO capacitors and they all performed to spec with very little change from room temperature to 100 degrees F. The polystyrene capacitor has a negative tempco (its capacitance decreases with increase in temperature). This time, the element I tested in the oven was coils wound on a T50-6 toroid form. The inductance was about 2 uH. The test was made with an oscillator using a 74HC04 Hex invertor operating at 7mHz. I first used this design in my P40-30 tranceiver design.(2) I didn't realize it at first, but I had, unknowingly, built up the well known VACKAR oscillator circuit. The original VACKAR circuit uses a bipolar transistor as the amplifying element. Instead, I used one element of the Hex inverter. The other sections of the Hex inverter are used for isolation. The one reason I first used this circuit was that the coil didn't require a tap or special input capacitors to provide the necessary feedback requirements. It made it easy to switch coils to give separate band operations. (See basic Circuit Figure 1).

The T50-6 toroid was chosen, based on other articles on toroids, as being the least temperature sensitive and the most readily available. I didn't try any other types.

I first checked, in the oven, the toroid coil that was just newly wound. I found typically it ran between a positive 45 and 60 Hz per deg F at the operating frequency of 7 MHz over a range of 60 to 100 degrees F. Then I boiled the coil in hot water for 5 minutes and again ran the same test over the same range. The results indicated that there was very little difference between the two but interestingly the tempco was now negative. In other words the frequency went up with increasing temperature by about the same value. I also tried coating a virgin coil with DuCo cement. The results were not that much different from the virgin one. I did these tests on three virgin coils with similar results. This is not to say that it may be good practice to do these things but they may not be necessary. I think coating the coil should be done from a mechanical viewpoint. Next I checked the MV104 to see what effect the temperature had on it. It was the only element

FIGURE 1

W6QIF OSCILLATOR



Note: C1,C2,& C3 are polystyrene caps

in the oven. The MV104 showed a tempco of positive 50 Hz per deg F (7000kHz) at the low end (bias voltage =zero) and a negative 125 Hz at the high end (7100kHz) over a similar temperature range. (This is logical since the effect of the MV104 is less at the high end in comparison with the other more controlling capacitances of the circuit which were causing temperature changes.) In other words, the frequency went down at the low end as the temperature increased and vice versa for the high end. Thus, at some point in the band, the tempco was zero. At this time I noticed that using a step change from zero to a plus voltage on the bias on the MV104 resulted in a slow drift in the frequency after the change had been made and then reached a steady state. The change was several hundred Hz. I changed the input resistor to the MV104 to a higher value thinking that the current into the unit was causing some internal heating. I didn't seem to make any difference. This probably wouldn't be of any concern in normal usage of the unit, but it was an interesting observation.

Because of this problem, I decided to see if using 1N4005s, in a similar configuration, would do the same. They didn't but, as luck would have it, I didn't connect the cathode to cathode together as is the case with the MV104 but just the opposite.

When I tried out the circuit in the oscillator, I found that the zero voltage gave a frequency at the high end and the high voltage at the low end. Just the opposite of the MV104. But I did notice something even more important, the bandwidth change was about 2.5 times that of the MV104 indicating a much greater capacitance change. I decided to call this vericap version a MVP40©30 since it will be first use on the P40-30 receiver. (See Fig 2 for a comparison of bandwidths compared to the MVP40-30. The same component values are used for each case). Well this sounded pretty good but how about the linearity? The MV104 wasn't that great so maybe the 1N4005s wouldn't be good either. To my surprise, they were much better (See Fig 3) (The test was made with the 1N4005s circuitry adjusted to give the same bandwidth coverage as the MV104.) I followed up the above test using the diodes connected the same as the MV104 and found results were poorer than the MV104. So you see, some times luck beats brains.

FIGURE 2

VERICAP #	BW
MVP40-30	184Hz
MVAM109	85Hz
NTE618	35Hz
MV104	82Hz

Connecting the diodes, in this fashion, apparently acts as a variable resistor in series with the tuning capacitor that is controllable by a varying voltage. (3) The capacitance is maximum with zero resistance in series which occurs when there is maximum conductance through the forward biased diodes, ie when the voltage of the bias is maximum. (Note: In the QRP CLASSICS (4) a statement is made that the change in capacitance is quite non linear below approximately 2 volts for a MV2109 which is similar to other varicaps of this style.)

It turns out that it appears this way on the curve shown on page 112 but if you note carefully the graph is not linear in this region and if look at the actual change in capacitance from .2 to 3 volts, is fairly linear. It is only when you get to the voltage of 3 volts and up it becomes non linear. This is the end you want to stay away from. In order to do this, the required change in frequency desired should be obtained by using a larger capacitance for coupling to the tuned circuit. Of course this brings up the problem of minimum capacitance which is also increased by making this change.

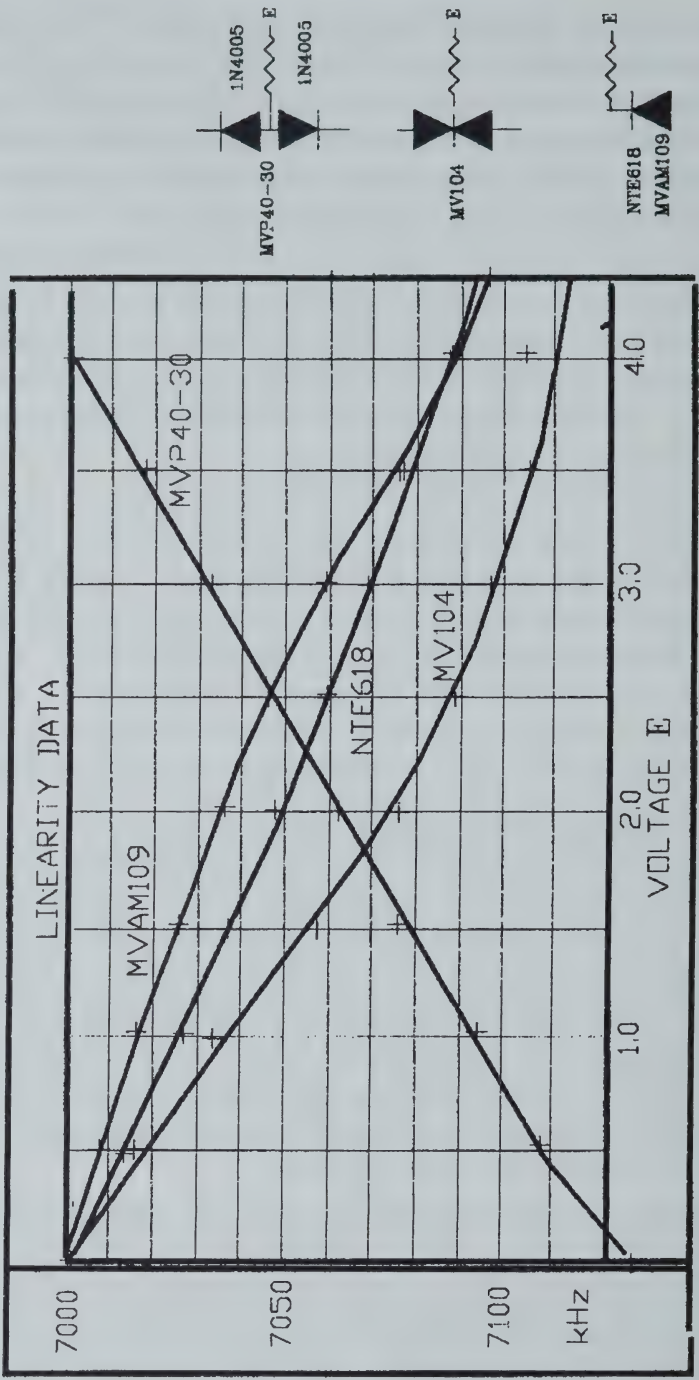
Therefore, a compromise must be found. One way is to switch in separate coupling capacitances for a wider range to get away from the non-linear portion of the curve. (Paralleling diodes to increase the tuning range brings up the same problem.) The answer is to use the MVP40-30 circuit that is very linear over almost all of its range.

So the MVP40-30 looked pretty good but how about the tempco effect? As with the MV104, there was a difference between the high end and the low end. The low end showed no change from 68 deg F to 93 deg.(50Hz on the MV104) But the high end showed a negative 83 Hz/F. The frequency went down with increasing temperature. The MV104 was 125Hz per degree F. A definite reduction in the temperature effect is seen. A sample was made of an additional two pairs of diodes with similar results.

In any event, the 1N4005s showed promise over the MV104 and are easy to find and very inexpensive. ($.10) I didn't try any other 1N400X diodes since these were the only ones I had. The other series should do equally as well. I also tried 1N914s for fun but they showed no change in frequency with varying voltage. I also had an NTE618 which is similar to an MVAM109. I ran a linearity check on this element and found it was not too bad over the 4.0 range. The MVAM109 was not quite as good. (See Figure 3)

The final configuration of the oscillator, using polystyrene capacitors in the other controlling parts of the circuit, resulted in a tempco of less than 100 Hz/deg F being positive at one end and negative at the other, giving some intermediate point at zero tempco. Of course this may not be

FIGURE 3


LINEARITY DATA
7000
7050
7100
kHz
1.0
2.0
3.0
4.0
VOLTAGE E
MVAM109
MVP40-30
NTE618
MV104
1N4005
1N4005
E
MVP40-30
E
MV104
E
NTE618
MVAM109

reproducible in every circuit of this kind, but it goes with out saying that the tempco will probably be much more, if certain precautions are not taken. There are, no doubt, cancellations taking effect that produced this low value and they can't always be counted on. I did note that the poly caps tend to cancel out the tempco of the toroids. If the tuning device is one of low tempco then the resulting overall tempco should be smaller. The active device also contributes to the change and the HC04 hex inverter has some effect causing the frequency to rise with increase in tempco but it isn't as sensitive as other elements.

Next, I removed two of the polystyrene capacitors on the input (C1 and C2) and replaced them with COG capacitors which are essentially NPO type capacitors around room temperature. The end result was the tempco for the original full circuit of less than 100Hz went to greater than a positive 200Hz/F. Thus it can be seen that the negative tempco of the poly caps did some reduction of the tempco. Combination of the NPO and poly caps in parallel could be used to further reduce the tempco.

OSCILLATOR INFORMATION

The waveform at the output of this oscillator is a square wave which is useful in driving a balanced mixer. A sine wave is also available using an isolator stage connected to the pin 1 of the 74HC04. This output can be used to drive an output stage of a transmitter with proper buffering. I found that the 74HC04 with a buffered output gave much better results as compared to non-buffered units. They are designated with a suffix of B1. For some reason the unbuffered units seemed to drift endlessly. (Use the type indicated in the parts list)

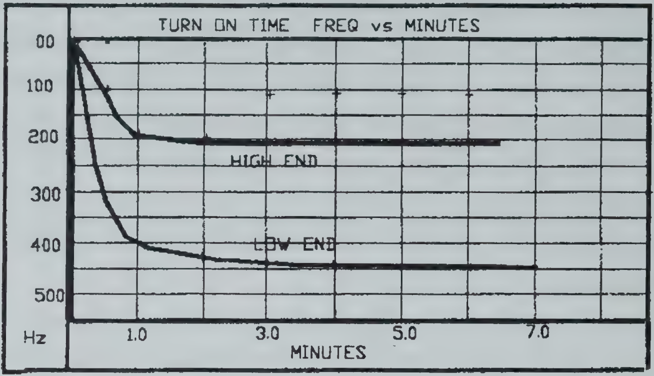
TURN ON TIME DRIFT

The turn on time (turning on the circuit from a cold start and observing the frequency shift as a function of time) of

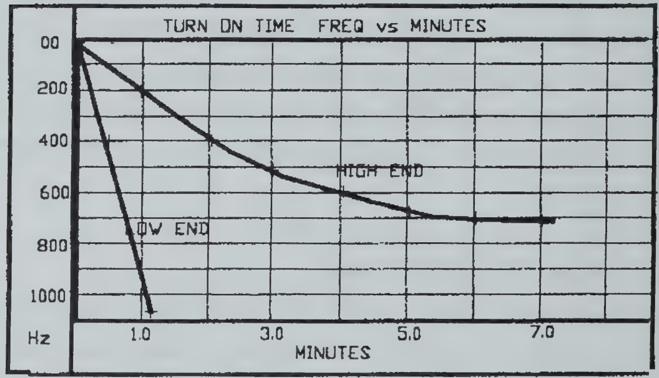
FIGURE 4

TURN ON DRIFT

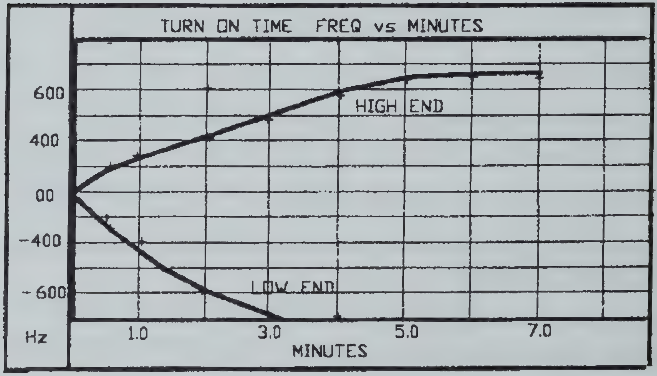
MVP40-30



MV104



NTE618



the oscillator was affected by the voltage level supplying the HC04. To keep the output voltage high and at the same keep the turn-on time small, the best voltage was about 4.5 volts. Figure 4 shows the difference in turn-on time for the MVP40-30 vs the MV104 in this oscillator circuit. The MV104 shows the problem I found that resulted in developing the new circuit, the change in frequency with a step input signal.

CONCLUSION

To keep the temperature effect low using analog devices is a cut and try proposition. It can be done if you have the time to experiment with various components. I found using an oven speeds up the process. I earlier used the temperature differential between evening and the next morning, but that was very slow. Also, using a blow pipe on various elements can be used to locate the most sensitive unit. By blowing thru the tube you can concentrate on each individual part and determine if the frequency changes in an up or down fashion. Of course, it is best to have a frequency counter to make these tests but listening for the oscillator in another receiver can be helpful.

Capacitor C3 can be changed to obtain greater band change or R1 can be used in the same fashion. Reducing R1 decreases the bandwidth change and visa versa.

TEMPERATURE ADJUSTMENTS

To fine tune the tempco, first determine the direction of frequency change as a result of a temperature change at both ends of the band. If the direction of change is such that the frequency goes up with an increase of temperature at both ends, then the polystyrene capacitors provides too much compensation. (Of course, the reverse is true if insufficient compensation is used). Reduce the value of one of the poly caps and in parallel with it connect a NPO or COG cap to give the same value as the original poly cap. The final result should give a positive tempco at one end of the band and a negative tempco at the other end resulting in a zero tempco somewhere in the middle of the band.

FINAL NOTE

After making the above tests, I decided to go back and check the tempcos. I found that I had no longer achieved less than 100 Hz per deg F, but 142Hz on the low end and 44Hz on the high end. Both showing that the frequency rose with increase temperature. This indicated that I had too much compensation from the polystyrene capacitors. This was the same circuit that I originally started out with. So why the difference? The only difference was the toroid coil which had undergone a boiling. So I wound another coil and replaced the boiled unit. Then end result was 33Hz on the low end and 12Hz on the high with one going up and the other going down. Thus, somewhere in the band the tempco was zero. If you recall, I mentioned that the tempco of the toroid went negative after boiling This is the same tempco of the polystyrene capacitors. So they were not canceling out each other as in the original configuration.

So my final conclusion is, in this circuit or any other where you are using polystyrene capacitors, do not boil the coils if you want to use their tempcos to cancel each other.

VARICAP ADVANTAGES

One nice thing about using varicaps as tuners is their small size and mechanical strength compared to the air tuning capacitor. Air tuning capacitors are now very scarce and, if available, are expensive. Since the vericaps are controlled by a variable voltage, one can use a multi turn pot to achieve band spread tuning. Where as the air caps require a mechanical reduction gear arrangement. (Very expensive)

The disadvantages of the available Vericaps were 1. They were temperature sensitive 2. Their change in frequency in response to a linear voltage change was very poor and 3. The range of capacitance change was limited. I believe the MVP40-30 will overcome these problems and hopefully not introduce any new ones.

I wish to express my thanks to John Pratt (N1UA) for his help and thoughts and acting as a sounding board for my ideas. He has checked out my designs and made valuable suggestions for improving them. In addition, to Dave Meacham (W6EMD) for his perusal of the article and helpful suggestions.

REFERENCES

1. Oscillator Designs with Varicaps, QRPp Vol III , Number3, Sept.1995
2. Pending article, by the author, on a Transceiver called the P40-30 that uses this oscillator.
3. QRP CLASSICS "The Fine Art of Improvisation" page 108
4. QRP CLASSICS " Tuning-Diode Application " Page 112

72 Jim Pepper W6QIF@i.x.netcom.com

PARTS LIST

Toroid T50-6	DC Electronics	
1N4005	DC Electronics	
	Mouser	583-1N4005
1K pot	DC Electronics	31VA301
	Mouser	"
39pF COG cap	DC Electronics	110COG390J50V
	Mouser	80-C315390J1G
LM317T	DC Electronics	
	Mouser	512LM317T
Polystyrene caps		
470pF	Mouser	23PS147
Hex Inverter/Buffered	Mouser	511-M74HC04 74HC04B1

Note: All of the above parts can be obtained from Mouser except the T50-6.

MOUSER ELECTRONICS 1000 N Main Street, Mansfield
Tx 76065-1514
1-800-346-6873
DC ELECTRONICS PO Box 3203 Scottsdale Az 85271-3203
1-800-467-7736

The QRP Improv Antenna

by

Joe Everhart, N2CX

This article came about because of the frustrations I've encountered trying to operate a ham rig while on business travel. It's not an uncommon situation for business travelers and others who want to make the best use of their time in rented rooms.

Now I've tried a variety of ways of dealing with the problems encountered. I've come to the conclusion that operating an HF rig with a skywire inside such a room is almost useless. Most places have metallic skeletons or outer skins which drastically attenuate RF energy (a waveguide beyond cutoff is often used, in fact, as an intentional attenuator!) And reception is hampered by a cacophony of AC line noise TV horizontal oscillator spectral picket fences and assorted digital hash.

Occasionally I'm lucky enough to find a window that opens and even more rarely an outside balcony on which to set up an antenna. But that's not too often - at least on those occasions when I lug along a travel rig. Now I hate to carry along too much so whatever I carry along has to be extremely small and light to fit inside my luggage in an almost negligible space.

I've decided that the best overall guarantee of success is to count on operating from outside the room. Given good weather and ham friendly public parks a lightweight dipole (perhaps a Gusher!) works well.

But more often than not, the weather sucks and there are no nearby parks.

I try to arrange a rental car whenever I have to stay more than a couple of days in one location so my plans now revolve around it. The car is a handy source of 12-volt power for a QRP rig, it offers and relatively comfortable operating position out of the weather, and it presents a reasonable ground plane for antennas.

Several options are presented in Reference 1, but for now I will concentrate on a compact, simple single-band monopole antenna.

Since it was the result of some judicious on the road parts acquisitions and was literally thrown together rather than carefully designed, I call it the Improv Antenna.

The idea is quite simple. It consists of a quarter wave wire monopole that uses an auto body (or other suitable conductive structure) to supply an RF ground. The key to its performance is having an effective ground plane. An auto's body is on the order of a quarter wavelength or so on 20 meters giving it a low loss resistance. And it's not too bad on 30 and 40 meters.

The quarter wavelength is a tradeoff among several factors:

1. It is resonant and gives a reasonable match to 50-ohm feedline without the need for a tuner or SWR bridge.
2. It should have better efficiency than a loaded whip due to its increased radiation resistance and not needing a lossy inductor.
3. A quarter wave wire for 20 meters is only a tad over 16 feet so it fits nicely in a suitcase. The whole shebang with connectors and a 25-foot length of coax feedline displaces only an extra pair of socks or shorts. A 40 meter wire is only marginally more bulky.
4. Small-gauge hookup wire can be set up quite stealthily if

suitable supports can be found.

5. The antenna is inherently good for only a single band but that's not much of a handicap for casual operation. Actually a ¼ wave wire for 40 meters can be used on 20 and 15 as will be shown later.

6. Hookup wire is expendable if need be and can be gotten almost anywhere if it has to be replaced.

Figure 1 shows the almost trivial schematic diagram. The antenna section, a quarter wave wire and ground are connected to a 50-ohm feedline.

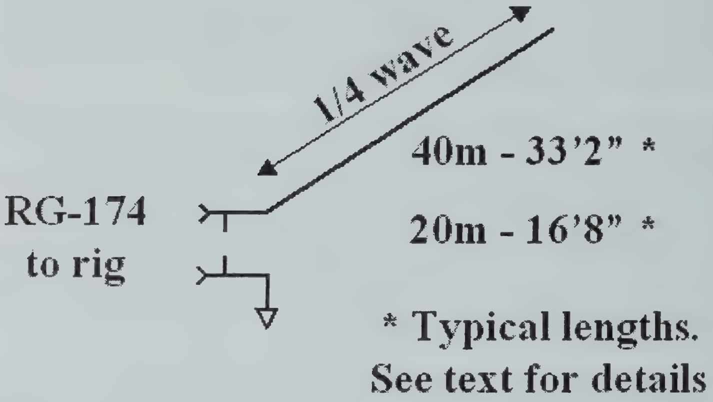


Figure 1 - Improv schematic diagram

Figure 2 shows the base connector I use. Since the antenna is made of light-gauge wire and is only for temporary setups, there is no need for excessive strength. A common 5-way binding post is soldered to the center pin of a chassis-mount BNC connector. One concession to strength is that I slipped a short length of brass tubing over the solder joint before soldering so that it would not be unduly stressed. The stripped end of the wire radiator slips into the binding post hole for mechanical and electrical connection. The antenna's ground connection is via a 6-inch length of hookup wire soldered to a lug on the BNC connector and terminated in a large alligator clip. 20-ga. stranded wire is best for longevity. A shorter lead would often work but use 6 inches since sometimes length matters.

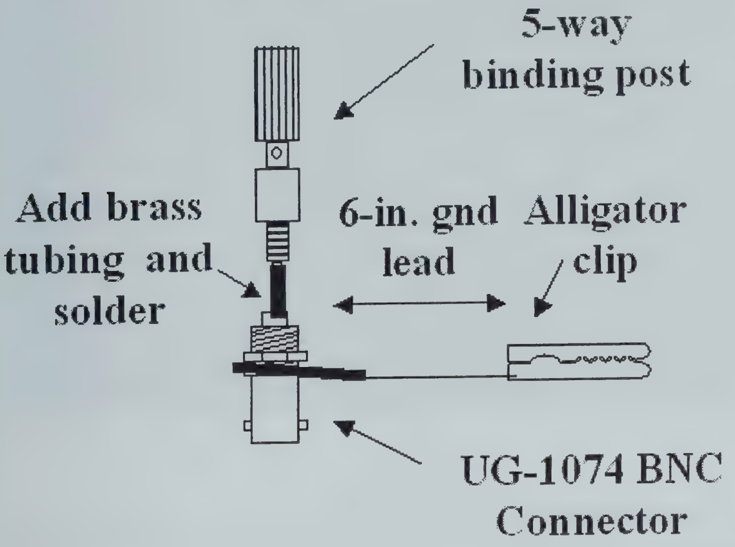


Figure 2 - Improv Base Connector

A complete parts list appears below.

Figure 3 is a photo of the Improv that I carry with me. Everything shown fits easily inside a plastic zipper bag. I have found the bag a necessity so that nothing is left behind and so that the wire doesn't end up twisting around clothes when airport baggage handlers sling my suitcase around. And these days, who would want a suspicious security bag finding loose wires and electronic parts during a luggage search?

The photo also shows tubular insulators on my wire. They are not really necessary to insulate the wire from the support lines unless you plan to operate in we weather. Just tie a knot

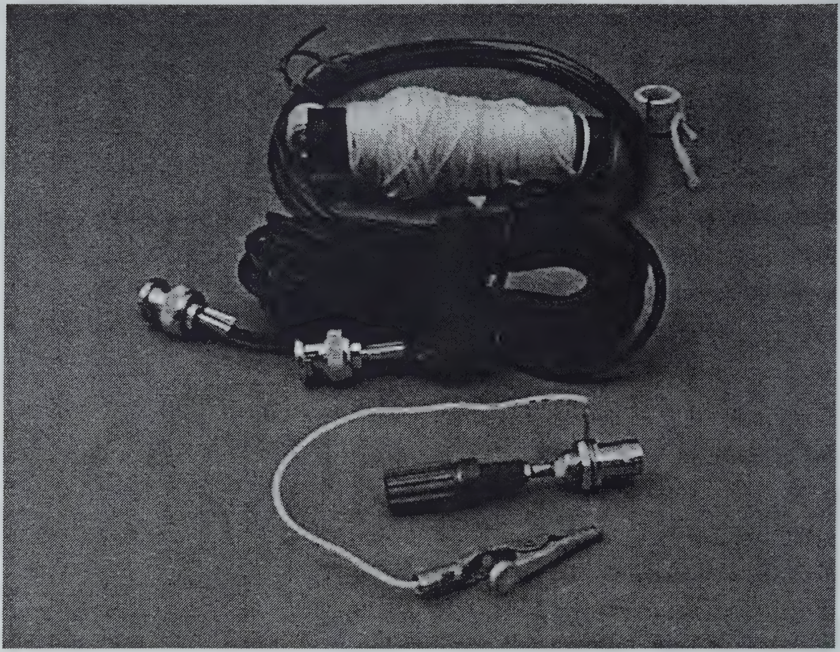


Fig. 3

in the wire end for attaching the line.

The ground lead needs to make a good low-resistance connection to a car chassis. Back in the "old' days of solid metal bumpers the easiest way of doing this was to clip right onto the front or rear bumper. But these days most sedans and minivans have plastic decorative bumpers backed by more collapsible plastic to absorb the force of a collision. In almost all cases I've been able to open a vehicle's trunk and find a metallic edge inside close to the trunk that will give a good solid electrical connection. Since this is inside the trunk it is not too damaging to scrap a little paint in an out of the way location. Just be sure to touch it up with some nail polish (yes' it's in the parts list) to ensure that it doesn't rust once you have returned the vehicle. Now some luggage and ski racks are electrically connected to the car body, but many are not. You can get an idea of whether or not that is true by connecting up the Improv to a receiver and touching the ground lead to the candidate location. Received signals should rise dramatically if there is a good ground connection.

I generally use light-duty kite string for support the Improv. Besides being stealthy, cheap and strong enough, it is ultimately very expendable. My usual source is the same dollar store that supplies the nail polish usage described later.) Getting the support line up into a tree or over a light pole is easy. You know those little plastic bottles of hair conditioner in your hotel room? They are the right weight to tie on the end of the kite string and pitch over a convenient limb. Now you know why they give you shampoo and conditioner.

For best results the wire should rise vertically away from the ground plane. The signal will be vertically polarized and suffer minimum loss from its surroundings. Figure 4 illustrates the ideal condition.

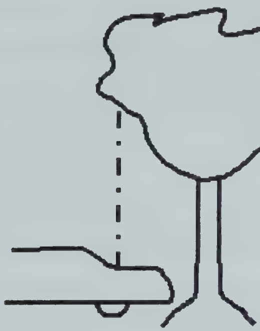


Figure 4 - Vertical Improv

More often I can't park my car directly under a non-conductive support but can find a nearby light pole or, better yet, a tree. The antenna works fine as a sloper as long as it is no more than 45 degrees or so from vertical as in Figure 5.

If you can find only short supports, lash the antenna up

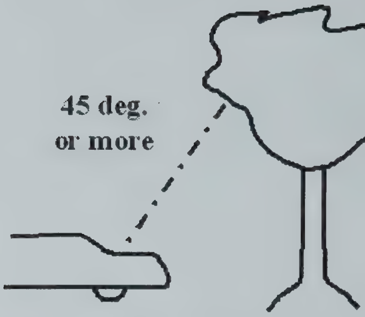


Figure 5 - Sloping Improv

as an inverted L. Try to keep the vertical portion as long as you can, but even if it's only 6 feet, that's better than a 6 foot mobile whip since the horizontal section of the wire acts as an almost loss-less top loading capacitance. And on 40 meters, it adds some high-angle radiation for close in QSO's.

The calculated quarter wave wire dimensions need to be tailored for each antenna due to the extra long ground lead. The procedure I used was to employ my personal vehicle as a ground by clipping the ground lead onto the grounded part of a mobile mount on my minivan and launching the wire over a buttonball tree out front of the house. After answering the usual questions my neighbor kids asked (they generally ask only once) I measured the resonant frequency of the antenna with my Autek RF-1. As expected the resonance was lowered due to the long ground connection. Then rather than cutting the wire short, I simply twisted it back on itself, a couple inches at a time until the resonance was raised to where I wanted it. See Figure 6. Tight capacitive coupling between the main wire and the twisted back portion effectively "short out" the overlapped length effectively shortening it electrically without having to cut any wire off. I've found that once the wire is resonated, no further adjustments are needed

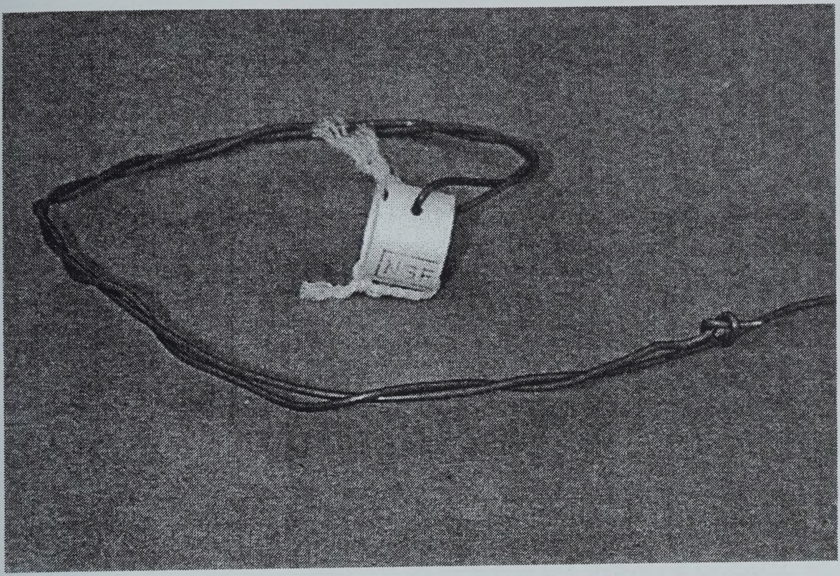


Fig. 6

in the field.

A “trick” can be used to employ a 40-meter quarter wave wire on multiple bands. The wire is used full length on 40 as a quarter wave. On 15 meters it is close to three quarter wavelengths long so it can be used as-is with slightly elevated SWR. On 20 meters, simply strip both ends of the wire and fold the wire back on itself, connecting both ends to the 5-way binding post. Connect the far end of the effectively halved length of wire (Fig 7) to the support line and you are in busi-

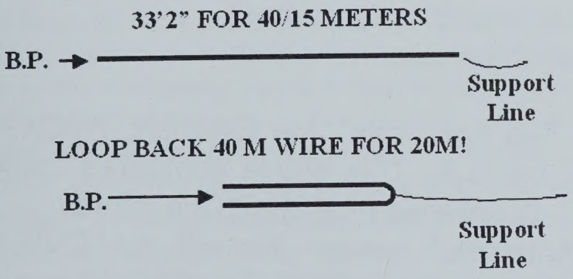


Figure 7 - Three bands from a 40-meter 1/4 wave wire

ness. However you may have to adjust the length slightly to get correct resonance on 20.

While I use the Improv for portable use in conjunction with an auto body, any decent ground can be used. For example if I were lucky enough to have a hotel room with a window that opened and it had a large metal frame, I could use the wire horizontally out the window to a nearby tree, using the window frame as a ground. Similarly an accessible metal balcony or rain gutter could be pressed into service. You could even use unconventional grounds such as chain link fences or metal highway guardrails so long as you could run the radiator to a suitable support. And going full circle to common portable antennas, the Improv can be used with a familiar radial ground system as a freestanding vertical. Gee, does that sound suspiciously like Dave Gauding's fishing pole verticals? Full circle indeed!

Improv Parts list

5-way binding post
BNC chassis mount female connector
6- inch length of 20 Ga. stranded insulated hookup wire
1 - large alligator clip
Optional brass tubing used to mechanically beef up solder connection to BNC center conductor
¼ wave length of wire (16' 8" for 20 meters, 33' 2" for 40/15 meters)
Length of cheap kite string for support
Optional "dollar store" clear nail polish

References:

1 "A Tale of Two Antennas" Joe Everhart, N2CX, QRP Homebrewer, Issue 9. This article compares using the KA5DVS PAC-12 Antenna (Ref 2) with the Improv

2. "PAC-12 Antenna," James, Bennett, KA5DVS, QRP Homebrewer, Issue 8, April, 2002. The PAC-12 is a small, very lightweight homebrew portable antenna.

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